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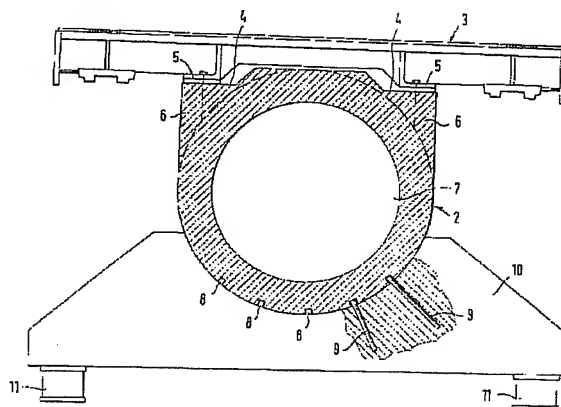
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(54) PASSAGE POUR RESEAUX DE TRANSPORT TERRESTRE

(54) TRAVEL WAY FOR LAND TRANSPORT SYSTEMS

(57)

Structural support system for traffic systems of all kinds, preferably for MSB (magnetic levitation trains) such as TRANSRAPID for example, with pre-fabricated travel way trusses containing at least one hollow reinforced pre-stressed concrete longitudinal girder projected by the track plate on both sides and placed on substructures produced either in the site-mixed concrete method or as pre-cast concrete elements, whereby the pre-stressed concrete longitudinal girders are finished as pre-stressed concrete stay pipes produced by way of the centrifugal concrete moulding production technique with flat upper support collars for the transversely placed continuous track plates, produced as separate elements.





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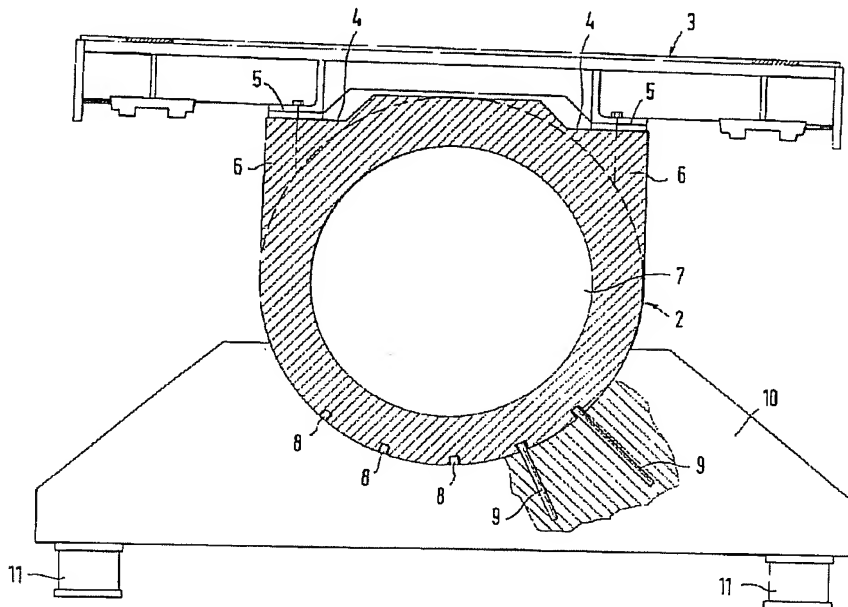
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(57) Abrégé/Abstract:

Structural support system for traffic systems of all kinds, preferably for MSB (magnetic levitation trains) such as TRANSRAPID for example, with pre-fabricated travel way trusses containing at least one hollow reinforced pre-stressed concrete longitudinal girder projected by the track plate on both sides and placed on substructures produced either in the site-mixed concrete method or as pre-cast concrete elements, whereby the pre-stressed concrete longitudinal girders are finished as pre-stressed concrete stay pipes produced by way of the centrifugal concrete moulding production technique with flat upper support collars for the transversely placed continuous track plates, produced as separate elements.

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ABSTRACT

Structural support system for traffic systems of all kinds, preferably for MSB (magnetic levitation trains) such as TRANSRAPID for example, with pre-fabricated travel way trusses containing at least one hollow reinforced pre-stressed concrete longitudinal girder projected by the track plate on both sides and placed on substructures produced either in the site-mixed concrete method or as pre-cast concrete elements, whereby the pre-stressed concrete longitudinal girders are finished as pre-stressed concrete stay pipes produced by way of the centrifugal concrete moulding production technique with flat upper support collars for the transversely placed continuous track plates, produced as separate elements.

TRAVEL WAY FOR LAND TRANSPORT SYSTEMS

The invention concerns a travel way for land transport systems, preferably for magnetic levitation trains such as TRANSRAPID for example, with pre-fabricated travel way trusses mounted on substructures produced either in the site-mixed concrete method or as pre-cast concrete elements; these trusses are to contain at least one hollow reinforced longitudinal section of pre-stressed concrete and transversely placed continuous track sections, which are produced as separate elements, projecting the pre-stressed concrete longitudinal girder on both sides.

One such travel way is known from DE 298 09 580 U1, whereby in that example the longitudinal travel way girders are made of steel.

Similar to the also proposed steel construction, unfavourable for its corrodibility and increased noise emission with the resulting environmental impact, the present pre-fabricated concrete trusses – in comparison with the DE 41 15 930 A1 for example – are principally designed in such a way, that a hollow reinforced longitudinal section of pre-stressed concrete with trapezoidal cross-section is employed, the upper wider basis of which is projecting on both the left and the right. The projection commonly extends to the total track width so that only the track-side components of the carrier and guidance system of the travel way (lateral guiding rails, runners and stator packs) need to be installed.

Such a pre-stressed concrete longitudinal section can only be manufactured reasonably economically as a vibrated pre-formed concrete element, which requires fanned reinforcing, in

particular at the ends. This in turn requires practically a solid cross-section towards the ends to accommodate the steel reinforcement rods, and in the hollow and center sections too there is still a wall thickness of at least 30 to 40 cm required to provide the necessary stability for the vibrated concrete method. In principle, these difficulties equally apply to a hybrid

5 construction, where the side projections of the pre-stressed concrete longitudinal girders are not designed to extend across the total track width but are kept somewhat shortened. Bolted on to the shortened projecting arms in an elaborate way are steel elements of exact dimensions, which themselves in turn form or carry respectively the track-side components of the carrier and guidance systems. Here too the pre-stressed concrete longitudinal girder with the
10 shortened projecting arms has to be produced through in-mould vibrating, which again results in the difficulties of the increased weight described earlier, this being undesirable not only because of the increased material requirements but in particular because of the problematic handling implications of the pre-cast components during their installation on the site.

15 The invention is therefore based on the task of designing a travel way for magnetic levitation trains of the kind described earlier in such a way, that the pre-stressed concrete longitudinal girders can be produced more simple, more economical, and with reduced wall thickness and therefore reduced weight.

20 The invention proposes to solve this task by designing the pre-stressed concrete longitudinal girders as pre-stressed concrete stay pipe sections with flat upper collars for the support of the track sections by employing the centrifugal concrete moulding production technique.

Separating the longitudinal girder from the track plates, whereby the track plates can be either reinforced concrete sections or of steel plate construction, i.e. by dropping the requirement for the concreting-on of the side-projecting arms supporting the track onto the pre-stressed concrete longitudinal girder, allows the construction of the pre-stressed concrete longitudinal girder as an essentially tubular, symmetrical concrete element moulded by centrifugal action. This technique of centrifugal concrete moulding not only allows reduced wall thickness and therefore reduced weight, but this method results in a continuous, hollow section with a large continuous inner cavity for the installation of wiring and service ducts. The support collars are to be partially formed by stiffening ribs protruding sideways from the essentially cylindrical pipe section, whereby these stiffening ribs are not to be confused with the flanges of the present track supports, which are projecting further by one scale of magnitude. By way of these protruding ribs for the provision of a slightly larger support area the flyweight of the girder – which by the way can be further counteracted during the production process through additional means, which will be referred to subsequently – is being kept small enough to make uncomplicated centrifugal concrete moulding production possible.

In contrast to constructions with pre-fabricated travel way trusses of approx. 20 – 31 m lengths, the track sections – by taking the invention further – are to consist of a number of longitudinally short, spaced track plates of preferably 6 m length approximately. These plate segments can be exchanged much easier and are individually detachable from their supports during maintenance and repair, and are therefore also service-friendly, in particular in the preferred steel plate configuration, are easy to machine and therefore can be cut to exact dimensions, in contrast to the present concrete-cast track sections. The individual plates forming a track section can be simply and lastingly bolted onto the pre-stressed concrete stay

pipe sections, similar to existing sleeper systems. As a further advantage it needs to be pointed out that the individual plates can be fitted accurately.

Splitting the track section of a pre-fabricated travel way girder of approx. 20 – 31 m length into a number of individual plates also has the advantage of a easier and more precise workability of these individual plates, as well as easier handling. A further advantage of splitting the track section into individual plates is the easier way of introducing lateral inclination of the track in curves and in particular the easier provision of transitional areas between the different inclination sectors.

The high temperature difference generally experienced with travel way trusses (solar radiation heating the track on top, while the pre-stressed concrete longitudinal girder below is shaded and consequently remains cool) and the resulting significant stresses can be managed a lot better with the bolted-on track sections, which to their advantage are further split into individual plates, than in monolithic track sections and travel way trusses. In comparison with a steel travel way, which is also lighter, in which the longitudinal girder is also made of steel, the noise resonance characteristics of the construction in accordance with the invention are considerably better, and, most importantly, no corrosion protection is required either.

In the case of a track construction on pylons, usually employing so-called A-frame pylon, the pre-stressed concrete stay pipe section positioned along the centre of the track section is to be equipped with subsequently concreted-on support consoles for bedding on the support pylons. For this purpose threaded sockets may be embedded in the pre-stressed concrete stay pipe section for the threading-in of anchoring rods engaging with a support console, and

furthermore the pre-stressed concrete stay pipe sections may in addition have an abraded surface in the bearing area of the support console, thus ensuring also that a better joint between pre-stressed concrete stay pipe section and support console is assured.

- 5 For the purpose of introducing camber of the track in curved sections, wedge pieces may be inserted between the support collars of the pre-stressed concrete stay pipe sections and the track sections, or – in the case of a very pronounced camber in curved sections in particular – the pre-stressed concrete stay pipe sections may be concreted-on to the support consoles in a rotated position.

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The creation of a travel way with centrifugally-moulded pre-stressed concrete stay pipe sections in accordance with the invention is also eminently suitable for travel way positioning at ground level. Presently employed in this application are either a continuous longitudinal central support wall or a multitude of low transverse support walls positioned at short intervals (spaced at 3 to 5 m), on which the pre-fabricated travel way trusses rest. The Transrapid carriage design, which wraps around the track side walls, requires the elevation of approx. 80 to 100 cm above ground, even for travel way positioning at so-called ground level. In addition to the increased expenditure required for the closely spaced transverse supports and the substantial weight of these transverse support walls, which have to be anchored deep in the ground, this method also results in high and annoying noise emission levels (loud rattling noise), as a consequence of the permanent air turbulence, among other things around the transverse support walls, caused by high travelling speeds.

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In order to avoid this, in accordance with the invention it is proposed for the application of travel way positioning at ground level, that two pre-stressed concrete stay pipe sections, spaced apart in parallel and joined in the bearing area, are both carrying the track section produced as a separate element, preferably in individual plate segments, and are supported directly by the foundations. In this application the pre-stressed concrete stay pipe sections need to have flattened sides next to the upper support collars, so that at a height of 80 cm and despite the positioning in parallel they only build up a total width of significantly less than the width of the track. In addition to the advantages regarding noise emissions referred to earlier, the construction in accordance with the invention by way of joined centrifugally-moulded pre-stressed concrete rectangular pipe sections with a height of 60 to 80 cm, which are supported directly by the foundations, has the advantage of requiring far fewer foundations per track section. While presently three foundations are required per track plate of 6,20 m, the construction in accordance with the invention makes do with two foundations placed at the ends of the pre-stressed concrete rectangular pipe sections' total length of 20 – 31 m. This leads to a significant simplification of the travel way erection.

In addition to that, the space between the centrifugally-moulded rectangular stay pipe sections is suitable for the protected installation of the wiring and service ducts. As a special advantage the essentially rectangular pre-stressed concrete stay pipes thereby may be bolted side-on to a rectangular steel frame in the bearing area, which is itself bolted to the foundations.

In the application of a travel way positioning at ground level in accordance with the invention with the centrifugally-moulded pre-stressed concrete rectangular stay pipe sections placed on end, these may be supported by the foundations through an intermediate wedge-shaped

member, so that special track supports are not required for each inclination level, necessitating special centrifugal moulds as a consequence.

To prevent the detrimental effect of sagging of the pre-fabricated travel way trusses installed unsupported over large sectors, on the one hand the pre-stressed concrete stay pipes may be produced with a slight upward arching, so that due to their own weight and the weight of the track section resting on them they end up in a perfectly level installed position. On the other hand the upward arching could be calculated so that the horizontal position is also achieved under traffic load.

In addition to that, to counteract the impact of the high carriage weight on the lower sectors of the pre-stressed concrete stay pipes, additional reinforcement could be provided in the form of either larger diameter or tighter packed tensioning steel rods in these areas.

For the production of the pre-stressed concrete stay pipes in accordance with the invention, in application of the same a centrifugal action concrete mould is envisaged, in which the profiled sheetmetal determining the outer shape of the pre-stressed concrete stay pipe section is to be fitted with stiffening ribs placed asymmetrically and spaced around the rotational axis in such a way that thereby in connection with the asymmetrically placed tensioning steel rods the flyweight created by the increased volume of concrete in the area of the support collars is neutralised. Thanks to this automatic flyweight compensation, which of course is only possible because the track sections are not concreted-on to the track support arms but are attached to the centrifugally-moulded pre-stressed concrete stay pipe sections as individual components, the centrifugal concrete moulding can be realised very economically and also with subsequently

high rotational speeds and therefore high concrete density and corresponding reduced wall thickness.

Further advantages, characteristics and details of the invention will become evident from the following description of some implementation examples as well as by way of the illustrations.

The following are depicting:

Fig. 1 a cross-section of a pre-fabricated travel way truss as per invention

10 Fig. 2 a side-on view of a travel way in the butt sector of two pre-fabricated travel way trusses as per Fig. 1, without the track plates,

Fig. 3 a schematic illustration of a section of track with camber in a curved sector,

15 Fig. 4 and 5 enlargements of the sections IV and V in Fig. 3 with depiction of the wedge-shaped bedding of the track plate onto the pre-stressed concrete stay pipe,

Fig. 6 a schematic illustration as per Fig. 3, in which the camber is achieved by the additional rotation of the pre-stressed concrete stay pipe,

20

Fig. 7 a cross-section through a travel way in ground level application with two joined, centrifugally-moulded pre-stressed concrete stay pipes, designed essentially as rectangular pipes,

Fig. 8 top view of a track section as per Fig. 7, where several track plates are supported by two rectangular pipes,

Fig. 9 a cross-section as per Fig. 7 through a track in a cambered curve,

Fig. 10 an enlarged cross-section of a pre-stressed concrete stay pipe with indicated tension reinforcement, and

Fig. 11 a schematic cross-section of a centrifugal mould for the production of a pre-stressed concrete stay pipe as per Fig. 10.

The travel way construction for a travel way positioning on pylons depicted in Figs. 1 and 2 – the pylon 1, which is several meters high, has only been depicted figuratively in Fig. 2 and has been totally omitted in Fig. 1 – consists essentially of a pre-stressed concrete stay pipe 2 and the track sections 3 produced as separate elements, whereby these track sections do not have the same length as the pre-stressed concrete stay pipe 2, but are made up of individual plates with consequently shorter lengths. This allows for significantly less complicated handling of the track plates, irrespective of the construction of these track plates 3 in either reinforced concrete or, as depicted, in steel plate configuration. The total separation however of the track sections and the basic longitudinal girder allows in particular the configuration of the longitudinal girder at least as a reasonably symmetrical and therefore only a limited amount of flyweight showing pipe, which consequently may be produced by employing the centrifugal concrete-moulding process. Frequently the whole superstructure contained in track section 3, together with the longitudinal girder, usually with a trapezoid cross-section flaring out towards

the top, has been produced as a single element, which made it practically impossible to employ the centrifugal concrete moulding process in a sensible way. Furthermore this element in any case had to be handled as one unit, irrespective of its production process. The huge weight, due to the increased wall thickness of the vibrated pre-stressed concrete longitudinal girders in connection with the weight of the attached one-piece track sections, made the erection of such pre-fabricated travel way trusses with a construction length of 20 – 31 m a most complicated installation process, as has been the precision of the track section surface.

Forming the support collars 4, onto which corresponding bedding sections 5 of the track plates 3 can be bolted, merely requires stiffening ribs 6, which protrude only marginally from the cylindrical configuration of the pre-stressed concrete stay pipe 2 and do not introduce a significant amount of flyweight, at least no flyweight or asymmetry in the sense that it would prevent centrifugal concrete moulding production.

The centrifugal concrete moulding production process results in a continuous huge inner cavity 7, which may be utilised for the installation of wiring and service ducts. During the centrifugal moulding of the pre-stressed concrete stay pipe 2, in the bearing area with the pylon 1, i.e. usually at the ends of the 20 – 31 m long pre-stressed concrete stay pipes, threaded sockets 8 are embedded, into which anchoring rods may be threaded. These provide anchoring in the support consoles 10, by way of which the pre-stressed concrete stay pipe 2 together with the track section 3 are supported on the pylons 1. The additionally provided, preferably spring-mounted support feet 11 are known as such and therefore do not need to be described here any further. The separation of the track sections from the pre-stressed concrete stay pipes 2 allows for a very uncomplicated introduction of camber into the track in curved sectors, as is

depicted in Figs. 3 to 5. For this purpose it is merely required to insert wedge plates 12 and an additional spacer block 13 in the mounting area between the track section 3 and the support pipe 2. Instead of, or if necessary in addition to this, it may also be an option, as per Fig. 6, to have the pre-stressed concrete stay pipe rotated around its rotational axis, i.e. is concreted-
5 on to the console 10 in its rotated position for example. The split design of the track sections into separate short individual plates is of particular advantage, especially with this track camber as per Figs. 3 to 5, since thereby the angle of inclination does not have to remain constant over the 20 – 31 m length of a pre-fabricated travel way truss, but in that the individual plates of approx. 6,20 m length could individually have varying inclination angles.

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Figs. 7 and 8 schematically depict a top view and a cross-section respectively of a travel way in ground level configuration. Here one can see one or more track plates 3 of approx. 6,20 m in length, which are laid over two pre-stressed concrete stay pipes 2', spaced apart in parallel, bolted together in the bearing area 14 through a joining rectangular steep pipe and bedded
15 straight down on the foundation 15. Foundations 15, which may be attached to additional abutment piers 16, only need to be provided with the spacing corresponding to the length of a pre-fabricated track section, i.e. in the depicted example approx. 20 – 31 m, while during the support of the pre-fabricated travel way girders employing transverse support walls with 3 m spacing nearly ten times as many foundations were required. In addition to the continuous
20 cavity 7' of the essentially rectangular-shaped pre-stressed concrete stay pipes 2', the void between the pre-stressed concrete rectangular beams is particularly suited for the installation of wiring and service ducts.

Fig. 9 depicts a cross-section as per Fig. 7, whereby a wedge-shaped plate 17 mounted on the foundation 15 produces a camber through track inclination.

Fig. 10 depicts an enlarged cross-section of a pre-stressed concrete stay pipe 2, in which the
5 tensioning steel rods 20 and 21 respectively, arranged in differing concentric planes 18 and 19
are also indicated. Therein the tensioning steel rods are packed tighter and are, if required,
also of a larger diameter in the lower half of the pre-stressed concrete stay pipe 2, in the
opposite half to the support collars 4, so as to achieve a higher level of reinforcement in this
lower section, which is particularly stressed by the weight of the applied load. This
10 asymmetrical placement of the reinforcement can now be utilised, together with an
asymmetrical placement of the stiffening ribs 22 for the stiffening of the profiled sheet metal
23 within a centrifugal concrete mould 24 as per Fig. 11, so that the increased steel weight in
the lower part of the pre-stressed concrete stay pipe to be moulded neatly balances the
increased concrete weight in the support collar area and the protruding stiffening ribs 6 in
15 order to avoid flyweight, and that as a consequence the centrifugal concrete moulding
production is possible in a particularly uncomplicated way and with particularly high rotational
speeds.

The claims defining the invention are as follows:

1. Travel way for land transport systems, preferably for magnetic levitation trains, for example TRANSRAPID, with pre-fabricated travel way trusses containing at least one hollow reinforced pre-stressed concrete longitudinal girder placed on substructures produced either in the site-mixed concrete method or as pre-cast concrete elements, and with transversely arranged, projecting the pre-stressed concrete longitudinal girder on both sides, as separate elements produced track plates (3), characterised in that the pre-stressed concrete longitudinal girders are finished as pre-stressed concrete stay pipes (2, 2') with flat upper support collars (4) for the track plates (3), produced by way of the centrifugal concrete moulding production method.
2. Travel way according to claim 1, characterised by the support collar being formed by stiffening ribs (6) protruding sideways from the essentially cylindrical pipe profile.
3. Travel way according to claim 1 or 2, characterised by the track plates (3) being reinforced concrete plates.
4. Travel way according to claim 1 or 2, characterised by the track plates (3) being of steel plate construction.
5. Travel way according to any one of claims 1 to 4, characterised by the track plate (3) of each travel way truss consisting of a number of longitudinally short individual plates, which are spaced and fastened to the top of the pre-stressed concrete stay pipes (2,2').

6. Travel way according to any one of claims 1 to 5, characterised in that in the travel way construction on pylons the pre-stressed concrete stay pipe (2) positioned in the longitudinal centre of the track is fitted with support consoles (10), subsequently concreted-on, for bedding on support pylons (1).
7. Travel way according to claim 6, characterised by the pre-stressed concrete stay pipes having threaded sockets (8) embedded for the purpose of threading-in of anchoring rods (9), which engage with a support console (10).
8. Travel way according to claim 6 or 7, characterised in that the pre-stressed concrete stay pipes (2) have an abraded surface at least in the bearing area of the support consoles (10).
9. Travel way according to any one of claims 1 to 5, characterised in that in the travel way construction at ground level two parallel pre-stressed concrete stay pipes (2') are joined at intervals and are supported directly by the concrete foundations (15).
10. Travel way according to claim 9, characterised in that the pre-stressed concrete stay pipes have flattened sides next to the upper support collars (4').
11. Travel way according to claim 10, characterised by the pre-stressed concrete stay pipes (4') being essentially constructed as rectangular pipes and placed on edge.

12. Travel way according to any one of claims 9 to 11, characterised in that the pre-stressed concrete stay pipes (2') in the bearing area (14) are bolted side-on to a steel frame, which is constructed as a rectangular profile and is itself bolted to the foundations (15).
13. Travel way according to any one of claims 1 to 12, characterised by wedge pieces (12) or, if required, spacer blocks (13) being inserted between the support collar (4) of the pre-stressed concrete stay pipes (2) and the track plates (3) for the purpose of introducing camber in curved sections.
14. Travel way according to any one of claims 1 to 13, characterised in that for the purpose of introducing camber in curved sections the pre-stressed concrete stay pipes (2) are concreted to the support consoles (10) while rotated around their longitudinal axis.
15. Travel way according to any one of claims 9 to 12, characterised in that the pre-stressed concrete stay pipes (2') are supported by the concrete foundations through a wedge-shaped intermediate member (17).
16. Travel way according to any one of claims 1 to 15, characterised in that the pre-stressed concrete stay pipes (2,2') are fitted with strengthened reinforcement in the form of thicker and/or tighter packed tensioning steel rods (20,21) in their lower section opposite the support collars (4,4').

17. Centrifugal concrete mould for the production of a pre-stressed concrete stay pipe for a travel way according to any one of claims 1 to 14, characterised by the pre-stressed concrete stay pipe being designed so that the detrimental effect of sagging of the mould as the result of the uneven pre-tensioning in the cross-section area is neutralised by a strengthening of the ribbing built into the mould in view of rotational symmetry and compressive strain considerations.
18. Centrifugal concrete mould for the production of a pre-stressed concrete stay pipe for a travel way according to any one of claims 1 to 15, characterised in that the profiled sheetmetal (23), which determines the outer shape of the pre-stressed concrete stay pipe (2,2'), is fitted with stiffening ribs (22) placed asymmetrically and spaced around the rotational axis (25) so that thereby, in connection with the asymmetrical distribution of the tensioning steel rods (20, 21), the flyweight created by the increased volume of concrete in the area of the stiffening ribs (6) is neutralised.
19. Travel way according to claim 1, substantially as hereinbefore described with reference to any one of the embodiments illustrated in the accompanying figures of drawings.
20. Centrifugal concrete mould according to claim 17, substantially as hereinbefore described with reference to any one of the embodiments illustrated in the accompanying figures of drawings.

21. Centrifugal concrete mould according to claim 18, substantially as hereinbefore described with reference to any one of the embodiments illustrated in the accompanying figures of drawings.

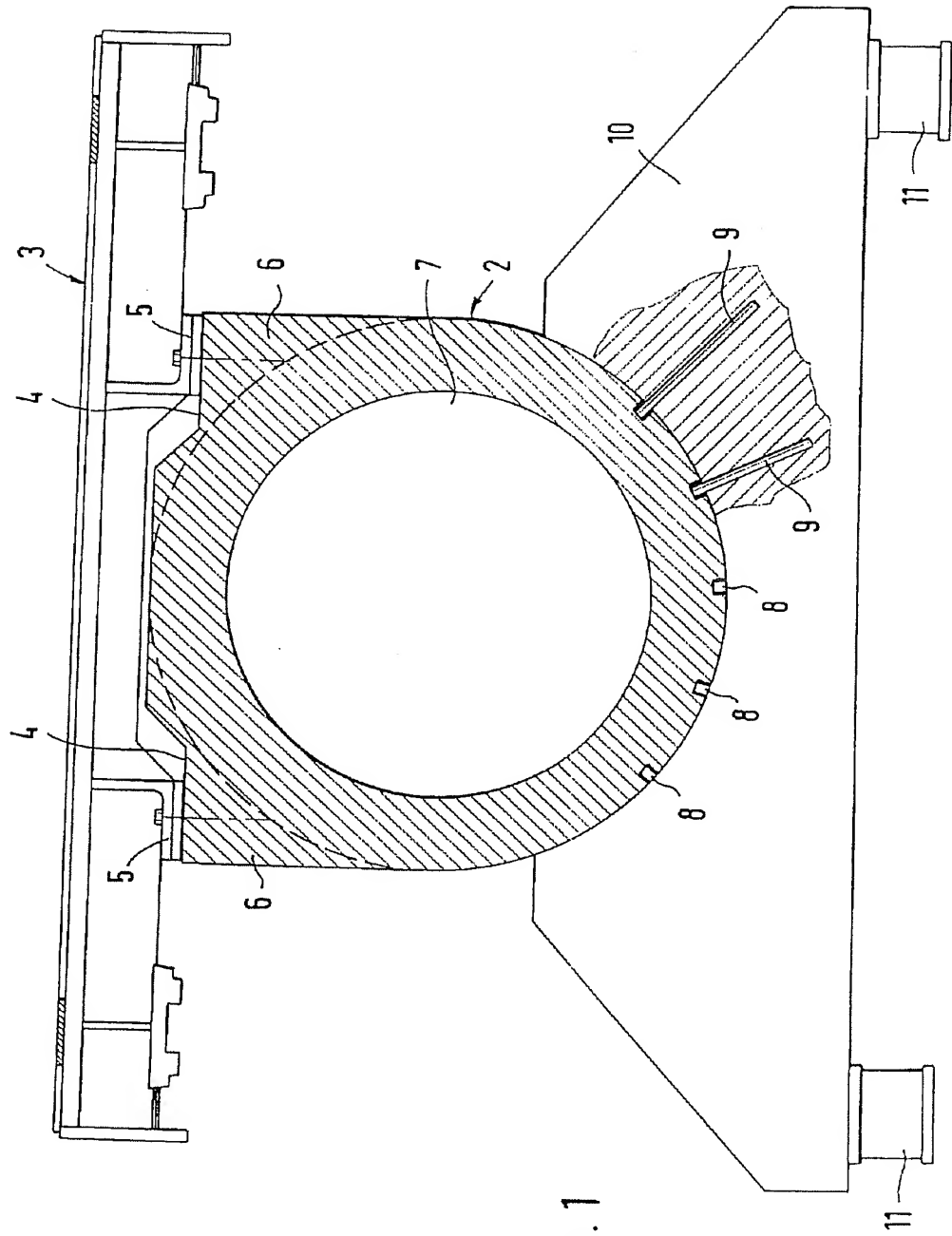


FIG. 1

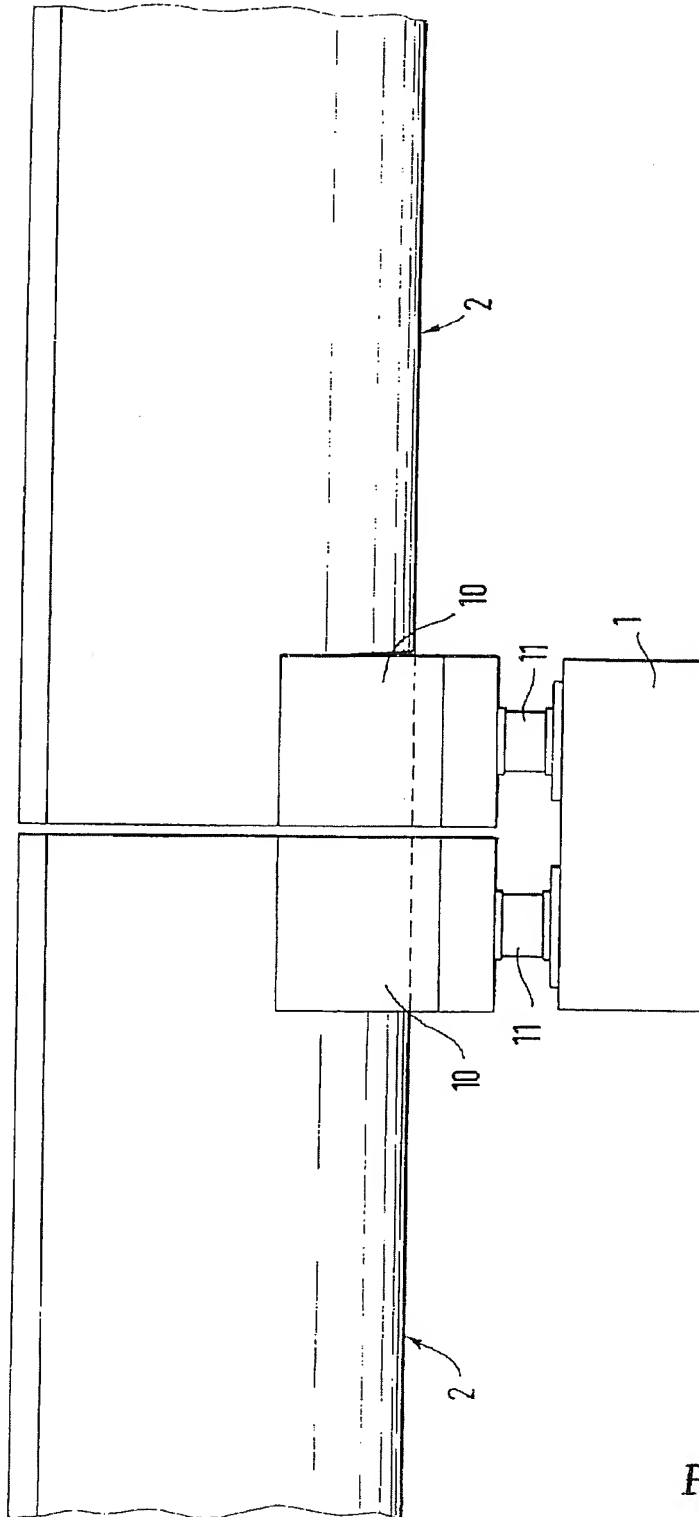


FIG. 2

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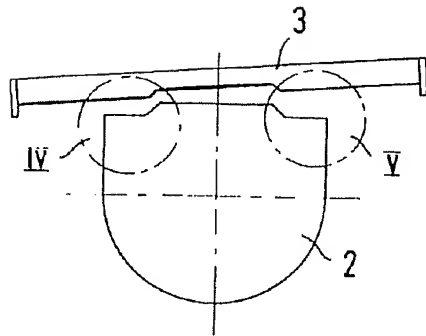


FIG. 3

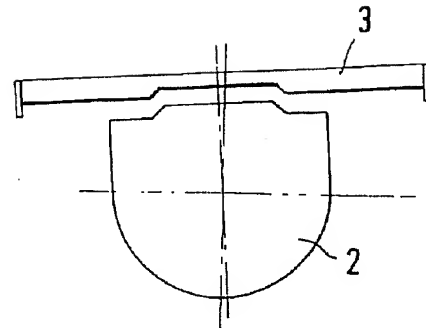


FIG. 6

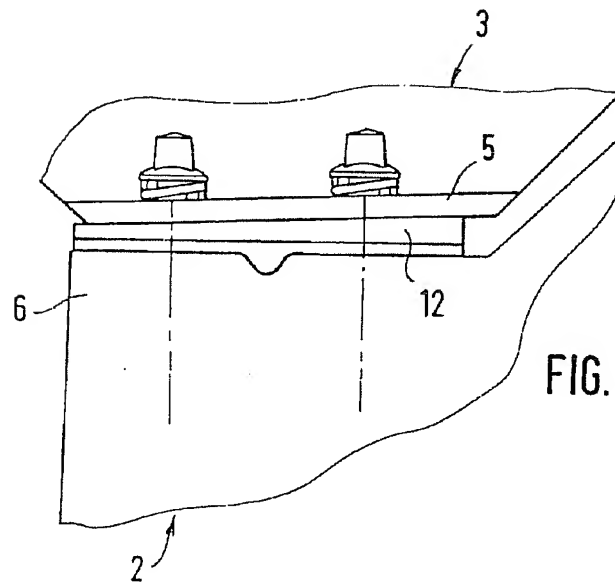


FIG. 4

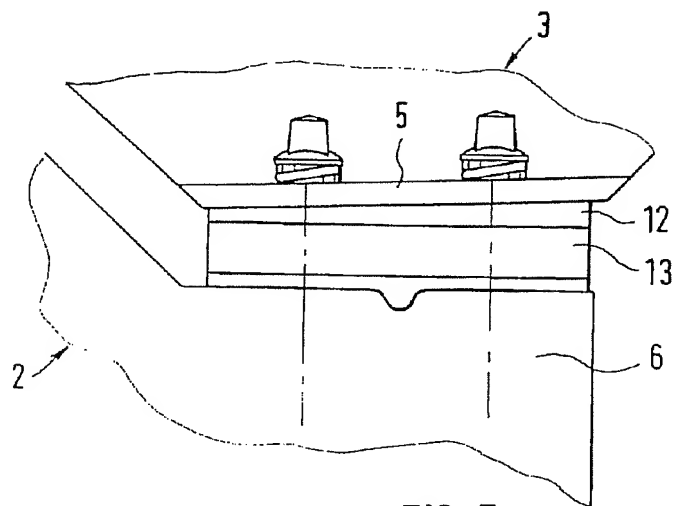
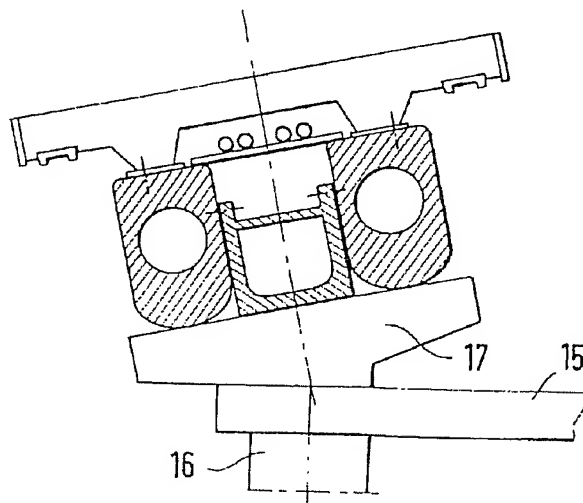
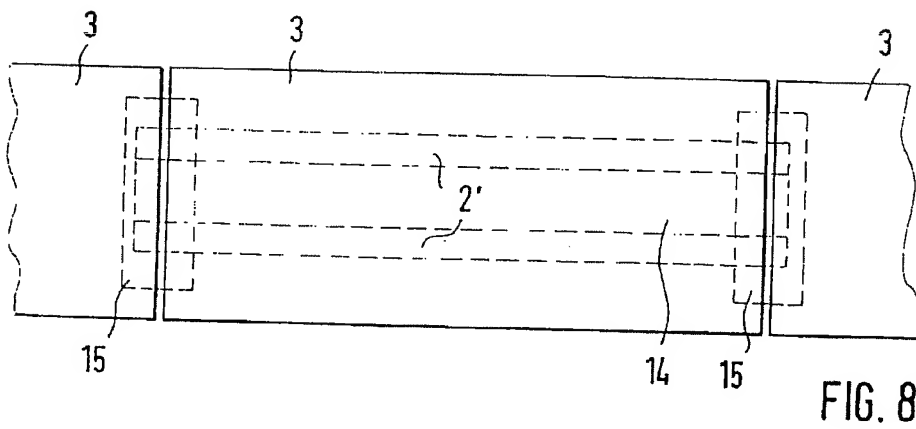
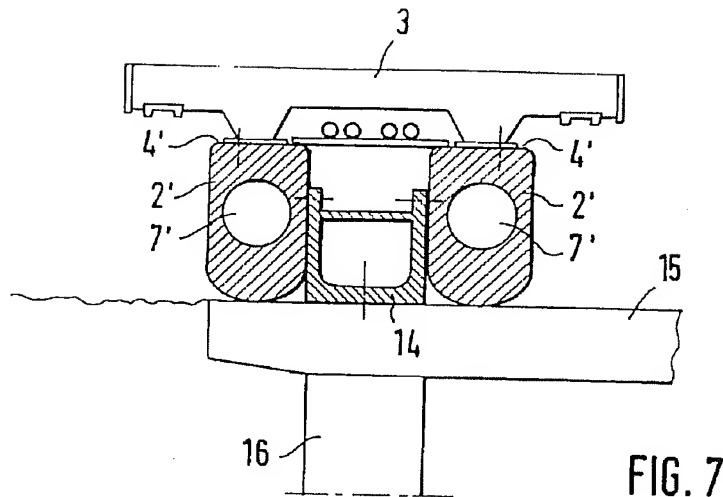


FIG. 5



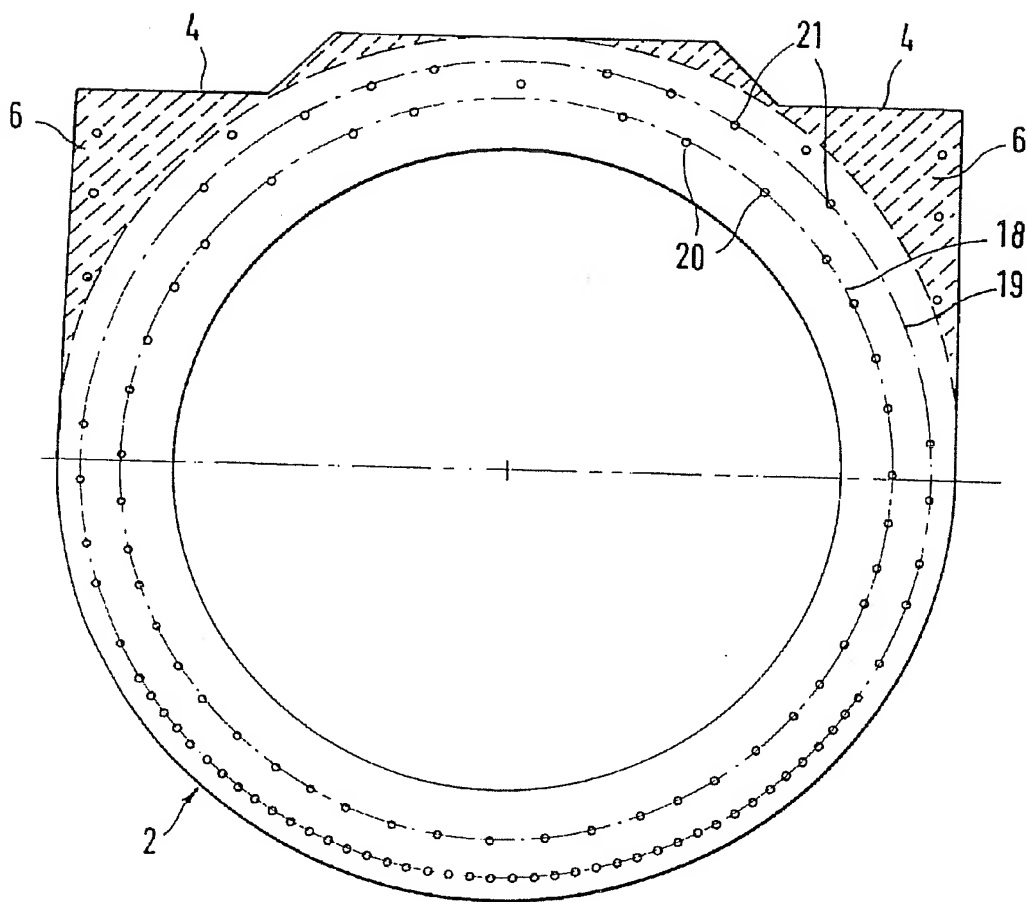


FIG. 10

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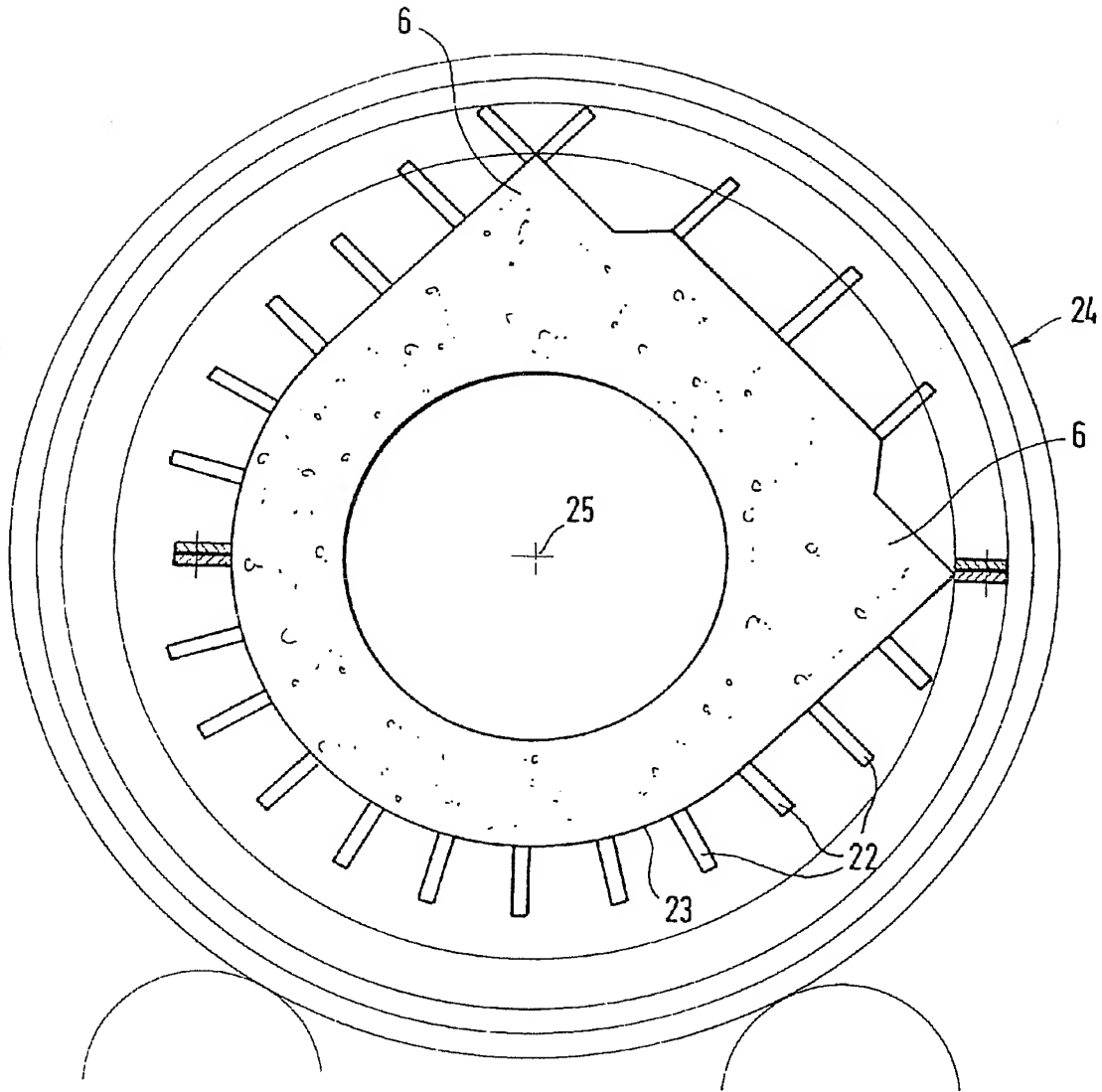


FIG. 11

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